selection of examples well fitted to test the student's progress. Many of these examples are of the familiar "academic" character, having little reference to natural phenomena; but from time to time, and particularly in the chapter on central forces, we meet with problems of high interest and importance. The effect of planetary perturbations on comets and the disintegration of comets into meteor swarms may be specially mentioned. Then the question of the stability of orbits is discussed at considerable length.

Here and there, however, a few points seem to call for remark. In § 222, Dr. Routh finds it convenient to introduce the term *vector*. It would have greatly facilitated his earlier work had he introduced the term at the very beginning. The conception of a vector quantity in mathematical physics is one which every student should get as soon as possible. It should be impressed upon his mind from the very start as something fundamental and far-reaching, and not merely as a convenient term enabling us "to avoid the continual repetition of the same argument."

The title of § 135 is "Discontinuity of a centre of force"—a most extraordinary collocation of words, and absolutely misleading. There can be no discontinuity of a *centre of force*; the discontinuity (if the term be used at all) is in the incomplete mathematical expression of the solution.

A certain looseness of expression is also apparent in the titles of §§ 186, 187, which are respectively, "Work of a central *force*," and "Work of an elastic *string*."

In Chapter vii. Lagrange's equations are introduced, and a variety of interesting problems in three dimensions discussed, *e.g.* motion of a particle constrained to move on a tortuous curve or on a surface. The case when the surface is an ellipsoid is investigated at considerable length, several of Liouville's results being introduced as examples for solution by the student.

Chapter viii. is devoted to "Some special problems," a title, however, which is a most incomplete description of its contents. The brachistochrone may, in a sense, be called a special *problem*, but, as developed by Tait, Townsend and others, its theory is of a very general character, and abounds in *theorems* of great interest. Following this there is a fairly complete discussion of the motion of a particle relative to the earth when the earth's rotation is taken into account—a problem of no small importance. After a few sections on inversion and conjugate functions, the final "special problem" taken up is Hamilton's theory of action. We doubt if any student, not otherwise instructed, could gather from Dr. Routh's pages the great importance of Hamilton's contributions to general dynamic theory. On p. 394 we read: "These are called *the Hamiltonian Equations of Motion*"; but there is no direct reference whatsoever to Hamilton, and in the index, under Hamilton's name, we find references to "Law of force in a conic" and to "Hodograph," but none to "Action"! In a book, one of whose really valuable features is its system of historic notes, such an omission is inexplicable. In striking contrast there is *full* recognition of the merits of Jacobi, who, as Hamilton himself expressed it in a letter to Andrews, "enriched by his comments" Hamilton's theory. One recommendation the student will do well to follow: let him refer to his "Thomson and Tait." The enunciation of Tait's problem (p. 401) contains a misprint which reduces the statement to an absurdity.

It is a reproach frequently cast by literary men that scientific writers lack style. There is not much scope for a cultivation of style in a mathematical treatise, but surely we have a right to expect good English. In the book before us there occurs with painful frequency the fault of the misrelated participle. On p. 7, an indefinite "it" is found "assuming the principles of the differential calculus"; on p. 145, a (dynamic) couple is represented as "remembering" something; on p. 150, the work done by forces is found capable of "selecting some geometrically possible arrangement," and so on.

By way of general summary we may, in conclusion, remark that, although the first chapter is open to serious criticism, and the book is somewhat marred throughout by a looseness of diction, Dr. Routh's "Treatise on the Dynamics of a Particle" is an important contribution to the literature of the subject. To the working student its value is enhanced by a well-selected stock of examples, many of which appear for the first time in a formal treatise. Some of the problems specially considered are of high interest, and the solutions in many cases are of practical value. In a word, the book fully sustains the reputation of its author as an experienced teacher, now bringing forth from his treasure-house things old and new, and appealing to a wider circle of ardent disciples who will be found wherever the English tongue is heard. C. G. K.

LABORATORY MANUALS OF INORGANIC CHEMISTRY.

Qualitative Chemical Analysis. By Chapman Jones. Pp. 213. (London: Macmillan and Co., Ltd., 1898.)

Practical Inorganic Chemistry for Advanced Students. By Chapman Jones. Pp. 239. (London: Macmillan and Co., Ltd., 1898.)

Advanced Inorganic Chemistry. By G. H. Bailey, D.Sc., Ph.D. Edited by William Briggs, M.A. Pp. 333. (London: W. B. Clive, 1898.)

THE first of the above books appears as one of the well-known series of "Manuals for Students." The tradition of these books is that they are not primarily written for a syllabus, but rather that an author has here an opportunity of developing his own ideas, and producing a book which has individuality. We turn, therefore, with considerable interest to this addition to an already abundant literature to see how far the author has contributed anything new or valuable to analytical teaching. As far as we can gather, the great defect which Mr. Chapman Jones believes to attend the study of analysis is that the student's mind is apt to get filled with a knowledge of isolated reactions, whilst really

"the use of such exercises, as are given in the laboratory, is to the would-be chemist exactly what the practising of exercises and scales is to the young musician. The aim is not merely to perform the exercise, but to do it in such a manner that it shall be practice in a thoroughly sound method of work."

It appears, therefore, that Mr. Chapman Jones sets his mind essentially on producing a correct executant.

Further evidence of this appears in the tables of separations, which are printed on parchmentised paper, and open out on each side of the stitching,

"so that if anything is spilled on to the book as it lies open at any of the tables, the result will not be so disastrous as it otherwise might be,"

and the underlying pages will be protected. This certainly suggests scale practising. Taking the author's purpose as he states it, we have carefully read the book and examined the methods prescribed. We believe certainly that the analytical methods are sound; but we should hesitate to say that, in this respect, this book is superior to a dozen others that could be named. It is written undoubtedly by one who has a mature knowledge of his subject, and the processes described satisfy all reasonable requirements in point of accuracy; but we find hardly anything noteworthy in the mode of presenting the subject or in the details—nothing certainly that will warrant us in saying that this is conspicuously *the* book for a sound method. In other respects, it makes no special claim. The sections of "Comparative Remarks" on the elements or radicals of a group are likely to be useful, but as an exposition of the theory of analysis as well as the practice the book leaves much to be desired.

Mr. Chapman Jones' second book is written to suit the syllabus of the Science and Art Department for practical inorganic chemistry in the advanced stage. The analytical part of it is adapted from the work just noticed. The rest includes the preparation of gases and some volumetric analysis. As all the topics of the syllabus are dealt with, the book will no doubt suit its immediate purpose. The mode of treatment calls for remark in one particular only. The preparations are grouped as follows:—Preparation of gases by the use of cold liquids, ditto by the use of hot liquids, ditto by the heating of dry substances, preparations involving distillation, preparations made in solutions. A protest must be entered against a mode of classification so entirely divorced from educational purpose. Even if there were practical convenience in it, which we do not admit, that would by no means justify a sequence of experiments dictated by considerations of merely having this or that piece of apparatus handy for use.

A book entitled "Advanced Inorganic Chemistry," written for "The Organised Science Series," and containing in the preface a statement that a certain liberality of treatment (of chemical physics) is justified by the importance attached in the syllabus to the subject, is calculated to raise prejudice in the mind of a reader. We make haste to say, therefore, that Dr. Bailey's book contains very little evidence, if any, of having been written to conform to a syllabus, or to provide information in that highly compressed and uninspiring form, which until recent times has seemed to prove most suitable for meeting the requirement of the Science and Art Department. The book begins with a short account of the properties of gases, including a good account of Avogadro's hypothesis, of dissociation, and of the methods of determining the composition of gases. In stating that equal volumes of *all* gases . . . contain the same number of molecules, the author, we think, underlines the wrong word. The whole advance made by Avogadro is surely embodied in the word *molecules:* it was not the introduction of the idea of equal numbers (as beginners are so often taught), nor the mere extension of an existing generalisation. The chapter on the atomic weights of the elements is excellent in most respects, but we regret to see the statement that a measure of the chemical attraction or affinity exerted between two elements is afforded by the heat developed by their union. An unqualified statement of this kind is calculated to instil a fundamentally wrong idea of the relationship between heat and chemical affinity. In the main part of the book dealing with the elements and their compounds, the mode of treatment is broad and luminous, and the information is well selected. Some few deficiencies in detail are to be found; but, on the other hand, there are many little features in which the book is an improvement on others of like scope. The following points are, perhaps, worth noting. Cryohydrates are mostly mixtures of ice and salt, and not definite compounds, as implied on pp. 60 and 67. On p. 103, the production of iodine by the action of sulphuric acid on potassium iodide may be better explained by the reducing action of hydriodic acid on sulphuric acid than by the mere decomposition of the hydriodic acid *per se*. The preparation of silicon from silicon dioxide and of boron from boron trioxide by means of magnesium, and also the preparation of silicon hydride, easily demonstrated in test-tubes, are not mentioned, nor is justice done to the energetic properties of boron. The preparation of potassium chlorate by electrolysis of potassium chloride is not mentioned; and though the electrolytic preparation of sodium is described, the figure which illustrates the process is hardly comprehensible. Three useful appendixes on crystallography, spectrum analysis, and chemical calculations, and a series of chemical problems, conclude the book. Owing to some printing accident, the appendix on spectrum analysis ends prematurely in the middle of a sentence. A. S.

THE MODERN BICYCLE.

La Bicyclette: sa Construction et sa Forme. Par Dr. C. Bourlet. Pp. 228. (Paris: Le Génie Civil; Gauthier-Villars, 1899.)

THIS is a reproduction of a series of articles which appeared in vol. xxxiii. of *Le Génie Civil*, and forms, in some measure, a supplement to the author's "Nouveau Traité des Bicycles et Bicyclettes." With the exception of an appendix on the theory of ball-bearings, the present work is non-mathematical in character, and is addressed to all cyclists who take an intelligent interest in their machines. The first chapter is devoted to an historical summary, then follow chapters on the frame, steering, bearings, gearing, change-speed gears, wheels and tyres, tricycles, accessories, and hygiene of touring.

The work is to be warmly welcomed, as adding to the far too scanty independent literature on the construction of the bicycle. We feel somewhat at a loss, however, as to the standpoint to be taken in reviewing the book. In the historical portion many events which, on this side of the Channel at least, are regarded as of primary importance are not even referred to—*e.g.* Kirkpatrick